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against the upper and in the latter against the lower side. Friction on the tube wall retarded the motion and gave a rotating movement to the solid bodies which tended to accumulate and clog the bore of the tube.

When the balls were of the same specific gravity as water they were swept along the middle of the tube and remained always in the "axial" or swiftest moving central current without touching the sides. In the normal circulation of the frog it can be shown that the white corpuscles pass along the upper wall of the blood vessel with a rotating motion. In order to make this observation the vessel observed must lie in a horizontal position while the web or sheet of tissue holding it is in a vertical plane. When the blood-vessel twists so that what was once the upper side becomes the under, the white corpuscle, carried on by the current, gradually crosses the stream and reaches the new top wall. These facts are easily explained when it is considered that the white corpuscles are specifically lighter than the blood plasma. The red blood corpuscles move in a crowd, without rotation, away from the vessel wall, in the so-called axial current, which is more marked the more rapid the circulation.

The red corpuscles are specifically scarcely heavier than the plasma, while the white are considerably lighter. The author points out the evident conclusion from his experiments, that the relation between the specific gravities of red corpuscles and plasma must remain during health in very fine adjustment. For were the red corpuscles to become decidedly either specifically lighter or heavier than the plasma, they must crowd against the vessel walls and the frictional resistance thus offered to the circulation might readily exceed the power of the heart to overcome.

It does not seem improbable that a disturbance of the specific gravity of the blood plasma in extensive albuminuria is the direct cause of the inflammations of different kinds, such as pleurisy, pneumonia, &c., to which there is a great tendency in that disorder. The tendency to hypertrophy in the left ventricle of the heart, and to general dropsy, may be explained in the same way.

In Asiatic cholera the water is rapidly drained from the blood, and the speedy collapse may have its solution in the clogging of the blood-vessels with corpuscles that are crowded against their walls.—*Journ. of Physiology, Vol.* v, *p. 66, 1884.*

PSYCHOLOGY.

EMOTIONAL FACULTIES OF ANIMALS.—It will be observed, on turning to the diagram, that I attribute to animals the following emotions, which I name in the probable order of their historical development: Surprise, fear, sexual and parental affection, social feelings, pugnacity, industry, curiosity, jealousy, anger, play, affection, sympathy, emulation, pride, resentment, æsthetic love of ornament, terror, grief, hate, cruelty, benevolence, revenge, rage, shame, remorse, deceit, ludicrous. This list, which leaves many of the human emotions without mention, exhausts all the emotions of which I have found any evidence in the psychology of animals. Before presenting this evidence in detail, perhaps it will not be thought superfluous again to insist that in attributing this and that emotion to such and such an animal, we can depend only upon inference drawn from actions, and that this inference necessarily becomes of less and less validity as we pass through the animal kingdom to organisms less and less like our own; so that, for instance, when we get as low down as the insects, I think the most we can confidently assert is, that the known facts of human psychology furnish the best available pattern of the probable facts of insect psychology. Still, as the known facts of human psychology furnish the best available pattern, we must here, while treating of the emotional faculties, follow the same method which we have hitherto followed while treating of the intellectual faculties, viz., while having full regard to the progressive weakening of the analogy from human to brute psychology as we recede through the animal kingdom downwards from man, nevertheless using the analogy, as far as it goes, as the only instrument of analysis that we possess.

I shall now proceed, as briefly as possible, to render the evidence which has induced me to ascribe each of the above named emotions to animals, and remembering that I have in each case written the emotion upon the diagram at the level of mental evolution where I have found the earliest evidence of its occurrence, it follows that in the majority of cases the emotion is present in the higher levels of mental evolution in a more highly developed form.

It will be observed that in the diagram I represent the emotions, as a class, to take their origin from the growing structure of mind at the same level as that at which the faculty of perception takes its origin. I do this because I think that as soon as an animal or a young child is able to perceive its sensations, it must be able to perceive pleasures and pains; hence, when the antecedents of a painful perception recur in consciousness, the animal or child must anticipate the recurrence of that perception—must suffer an ideal representation of the pains, and such suffering is fear. And that, as a matter of fact, fear of this low or vague order is manifested at about the second or third week of infancy, is the general opinion of those who have most carefully observed the development of infant psychology. To specify the class in the animal kingdom where a true emotion of fear arises is clearly a more difficult matter, and indeed it is impossible to do so in the absence of any definite knowledge as to the class in which perception first arises. But while, as previously explained, I am not able to say whether or not the Cœlenterata, and still less the Echinodermata, are able to perceive their sensations, I think the evidence becomes very strong in the case of insect larvæ and worms. And that both the one and the other manifest striking symptoms of alarm in the presence of danger may be easily shown.

With reference to young children, Preyer is of opinion that the earliest emotion is one of surprise or astonishment upon perceiving any change or strikingly novel feature in the environment. In deference to his opinion, therefore, I have placed surprise upon the same level of emotional development as fear, but of course in both cases this level is so low that it is but the germs of such emotions that are here supposed to be present.

This earliest stage of emotional development (18) I have made to correspond with "emotions preservative of self." The next stage (19) I made to coincide with the origin of "emotions preservative of species;" and of these the first to appear are the sexual. In the animal kingdom—or rather let us say in the psychological scale—these emotions are first unequivocally exhibited by the Mollusca, which on this account, as well as for the reasons given while treating of the association of ideas, I have made to fill the corresponding level on the other side of the diagram.

The next level (20) is occupied by parental affection, social feelings, pugnacity, emotions conducing to sexual selection, industry and curiosity. The level, therefore, corresponds with the origin of the branch marked social emotions in the central psychological tree, and with the earliest recognition of offspring on the side of the intellectual faculties. The animals which first satisfy all these conditions are the insects and spiders. For here, even if we exclude the Hymenoptera, we have evidence of parental affection in the care which spiders, earwigs and sundry other insects take of their eggs and broods. Again, numberless species of insects are highly social in their habits; others are highly pugnacious; some are conspicuously industrious; most flying insects display curiosity; and, according to Mr. Darwin's elaborate inquiries, it is also in this class that we find the earliest evidence of sexual selection.

Coming now to level 21, I have assigned to it the first appearance of the emotions of jealousy, anger and play, which unquestionably occur in fish. On level 23 I have placed the dawn of affection other than sexual, in view of the evidence of the emotional attachment of a python which was exhibited toward those who had kept it as a pet.

On level 24 I have placed the dawn of sympathy, seeing that this emotion seems to be unquestionably, though very fitfully, displayed by the Hymenoptera, which for other reasons I have felt obliged to assign to this comparatively high stage of psychological development.

On the next level (25) I have given emulation, pride, resentment, æsthetic love of ornament, and terror as distinguished from fear. All these emotions, so far as I have been able to ascertain, first occur in birds; and in this class some of the emotions which I have already named as occurring in lower classes are much more highly developed.

Next we arrive at grief, hate, cruelty and benevolence, as first displayed in some of the more intelligent of the Mammalia. Grief is shown by pining, even to death, upon the removal of a favorite master or companion; hate by persistent resentment; cruelty by a cat's treatment of a mouse; and benevolence by the following instances which I have met with since the publication of Animal Intelligence. Writing of a domestic cat, Mr. Oswald Fitch says, that it "was observed to take out some fish bones from the house to the garden and, being followed, was seen to have placed them in front of a miserably thin and evidently hungry strange cat who was devouring them; not satisfied with that our cat returned, procured a fresh supply, and repeated its charitable offer, which was apparently as gratefully accepted. This act of benevolence over, our cat returned to its customary dining place, the scullery, and ate its own dinner of the remainder of the bones." An almost precisely similar case has been independently communicated to me by Dr. Allen Thomson, F.R.S. The only difference was, that Dr. Thomson's cat drew the attention of the cook to the famishing stranger outside by pulling her dress and leading her to the place; when the cook supplied the hungry cat with some food, the other one paraded round and round while the meal was being discussed, purring loudly. One further instance of the display of benevolent feeling by a cat will suffice. Mr. H. A. Macpherson writes me that in 1876 he had an old male cat and a kitten aged a few months. The cat, who had long been a favorite, was jealous of the kitten and "showed considerable aversion to it." One day the floor of a room in the basement of the house was partly taken up in order to repair some pipes. The day after the boards had been replaced the cat "entered the kitchen (he lived almost wholly on the drawing-room floor above), rubbed against the cook and mewed without ceasing until he had engaged her attention. He then, by running to and fro, drew her to the room in which the work had taken place. The servant was puzzled until she heard a faint mew from beneath her feet. On the boards being lifted the kitten emerged safe and sound, though half starved. The cat watched the proceeding with the greatest interest until the kitten was released; but on ascertaining that it was safe he at once left the room without evincing any pleasure at its return. Nor did he subsequently become really friendly with it."

On the next level I have placed revenge as distinguished from resentment, and rage as distinguished from anger. In Animal Intelligence I give some cases of apparent vindictiveness occurring in birds; but as the exact nature of the emotions in these cases appears to me somewhat doubtful, I here disregard them, and place revenge on the psychological level which is occupied by the elephant and monkeys, in which animals this passion is very conspicuous. The same remarks apply to rage as distinguished from the less violent display of hostile feeling which is suitably expressed by the term anger.

Lastly, at level 28 we arrive at the highest products of emotional development which are manifested in animal psychology, and therefore at the highest of those products with which the present treatise is concerned. These are shame, remorse, deceit and the emotion of the ludicrous. For instances of the display of these emotions by dogs and apes, I need merely again to refer to Animal Intelligence.

In this brief sketch of the emotional faculties as they occur in the animal kingdom, my aim has been to give a generic rather than a specific representation. I have therefore omitted all details of the emotional character of this or that particular animal, as well as the narration of particular instances of the display of emotions.—*Romanes' Mental Evolution.*

THE MEASUREMENT OF HUMAN FACULTY.—Mr. F. Galton, M.A., F.R.S., delivered, reports the *English Mechanic*, the Rede lecture at Cambridge, last spring, taking for his subject "The measurement of human faculty." After briefly describing the art of measuring human faculties as the "dawn of a new and interesting science," Mr. Galton said that his new evidence, which he had taken some pains to obtain, showed that the actions of men are "governed by cause and effect;" but if the conduct of man is the result of some external influence, then such knowledge as he has obtained is of little service. Mr. Galton concluded by suggesting that a laboratory should be opened at Cambridge to investigate this "new science." An anthropometrical laboratory will be opened at the Health Exhibition by Mr. Galton.

ANTHROPOLOGY.[1]

THE ANNALS OF CHIMALPAHIN.—Domingo Francisco de Saint Anton de Chimalpahin, born in 1579, was a Mexican. He was descended from the kings of the State of Tzacualtitlan-Tenanco-Amaquecan, whose first sovereign reigned 1269–1338. Chimalpahin was versed in astronomy, history, geography, and in the study of the antiquities of his country. He composed in Nahuatl, by the aid of our alphabet, eight relations, or annals. They form part of the collection of Boturini. They were found by Aubin and their publication commenced. M. Rémi Siméon was associated with Aubin and copied a part of the annals. They are chronological tables, containing, besides the genealogies of kings, princes, princesses and lords, mention of the principal political

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[1] Edited by Prof. OTIS T. MASON, National Museum, Washington, D. C.